

REMARKS

In response to a Final Office Action dated May 27, 2004 and subsequent to the Notice of Appeal filed on September 2, 2004, Applicants are filing a Request for Continued Examination pursuant to 37 C.F.R. § 1.114. At the time of the Final Office Action, claims 1, 30-38, 40-44, 47-56, 58, 60-62, 64, and 65 were pending. The Examiner rejected claims 1, 30-38, 60-62, 64, and 65 and allowed claims 40-44, 47-56, and 58. Applicants thank the Examiner for allowing claims 40-44, 47-56, and 58.

Independent claims 1, 30, and 60 have been amended to include subject matter indicated by the Examiner as allowable. Upon entry of these amendments, the claims that remain pending in the present application are believed to be in condition for allowance. In view of the foregoing amendments and the following remarks, Applicants respectfully request reconsideration and allowance of all pending claims.

Rejections Under 35 U.S.C. § 102

The Examiner rejected claims 1 and 30-32 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,066,558 to Kawano et al. ("the Kawano reference"). Specifically, the Examiner stated:

Claims 1, 30-32 are rejected under 35 U.S.C. 102(e) as being anticipated by Kawano, et al. (US 6,066,558).

Kawano discloses forming on a semiconductor substrate having a contact, depositing a conductor layer (col. 6, lines 59-67), forming an impurity layer in the contact hole after about the last 30% of the conductor has been deposited (col. 7, lines 50-60), said impurity lowering the melting point of the conductor, and reflowing the conductor at a temperature to cause reflow (col. 8, lines 25-35 and col. 9, lines 22-40). The steps are performed in order (Fig. 2D-H). The temperature is within the recited range. The impurity is Ti(Fig. 2F).

Applicants respectfully traverse the rejection of the pending claims. Anticipation under section 102 can be found only if a single reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 227 U.S.P.Q. 773 (Fed. Cir. 1985). For a prior art reference to anticipate under section 102, every element of the claimed invention must be identically shown in a single reference. *In re Bond*, 910 F.2d 831, 15 U.S.P.Q.2d 1566 (Fed. Cir. 1990). To maintain a proper rejection under section 102, a single reference must teach each and every element or step of the rejected claim. *Atlas Powder v. E.I. du Pont*, 750 F.2d 1569 (Fed. Cir. 1984). Accordingly, Applicants need only to point to a single element not found in the cited reference to demonstrate that the cited reference fails to anticipate the claimed subject matter.

Independent claim 1, as amended, recites a method of processing a semiconductor substrate, the method comprising forming an impurity layer in a conductor layer “*wherein the impurity layer is formed intermittently during about the last 30% of the deposition of the conductor layer.*” On the other hand, the Kawano reference discloses “a multilevel interconnection forming method for forming a semiconductor device, in which aluminum filled in a hole connecting wiring by CVD can be planarized.” Kawano, col. 3, ll. 22-5. This multilevel interconnection forming method includes depositing a metal film on an insulating film of a substrate, forming an interlayer dielectric film on an entire layer of the substrate, forming a hole at a predetermined position of the interlayer dielectric film, and filling aluminum into the hole by a method such that aluminum is filled at a volume ratio *smaller than 100%* with respect to the hole. *Id.* at col. 3, ll. 29-41. The Kawano reference teaches that the hole is filled such that the uppermost end of the filling’s convex portion is equal or lower than the level of the upper end opening portion of the hole. *Id.* at col. 7, ll. 51-4. The

Kawano reference clearly does not teach that the impurity layer is *formed intermittently* during about the last 30% of the deposition of the conductor layer, as recited in claim 1.

Independent claim 30 recites “depositing an impurity into the contact hole, the impurity causing the melting point of the conductive material to lower, wherein depositing an impurity comprises *intermittently* depositing an impurity during the deposition of the conductive material.” The Kawano reference does not disclose these features. Specifically, the Kawano reference discloses:

In this reflowing process, aluminum alloy forming the metal layer 66 is heated, thereby causing fluidization of aluminum alloy, and aluminum alloy flows into the via hole 12 due to this fluidization. In this manner, the concave portion 68 is filled with aluminum alloy and the surface is planarized (see FIG. 2H). In this case, the volume of the concave portion 68 is very small due to existence of the plug 22, and therefore, the reflowing temperature may be set within a relatively low temperature range of, for example, about 350°C. to 420°C. The reflowing temperature is lower than the reflowing temperature (e.g., 450° C.) adopted in a conventional filling method. Therefore, organic material having a low dielectric constant, which has a low heat resistance, can be used for forming an interlayer dielectric film.
Col. 9, lines 24- 38.

Applicants respectfully assert that the above passage, which was cited by the Examiner in Final Office Action, does not anticipate claim 30, as amended. Specifically, the Kawano reference is directed to the process of reflowing the conductor. As the passage cited above makes clear, in this reflowing process, aluminum alloy is heated to a reflow temperature that is lower than the temperature conventionally used for reflowing. The Kawano reference explains that reflow occurs at a lower reflow temperature because the volume of the concave portion at the upper most end of the hole is very small. However, the Kawano reference does not teach or suggest that the impurity deposited on the conductor layer in the hole causes the melting point of the conductive material to lower, wherein

depositing an impurity comprises *intermittently* depositing an impurity during the deposition of the conductive material. Accordingly, the Kawano reference does not anticipate independent claim 30 and the claims dependent thereon.

Rejections Under 35 U.S.C. § 103

The Examiner rejected claims 33-35, 37, 38, 60-62, 64, and 65 under 35 U.S.C. § 103(a) as being unpatentable over Kawano. Specifically, the Examiner stated:

Kawano is silent with respect to migration out of the contact hole and about the degree of lowering of the melting point and of the impurity not forming an alloy.

With respect to the formation of an alloy, because the reflow is at a low temperature, it would have been obvious to one of ordinary skill in the art at the time of the invention that the impurity would not have formed an alloy because of the low temperature of the reflow.

With respect to the degree of lowering of the melting point, because Kawano teaches Ti, it would have been obvious to one of ordinary skill in the art to expect the recited degree of lowering of the melting point, because Ti is one of the impurities disclosed by applicant. With respect to migration out of the contact hole, this is within the ordinary skill in the art to choose the impurity with the desired properties, as Kawano teaches that other impurities may be used (col. 8, lines 25-38).

Office Action dated May 27, 2004, page 4.

Applicants respectfully traverse this rejection. The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (PTO Bd. App. 1979). Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the modification. *See ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572,

1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). The mere fact that a reference can be modified does not render the resultant modification obvious unless the prior art also suggests the desirability of the modification. *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d. 1430 (Fed. Cir. 1990). Accordingly, to establish a *prima facie* case, the Examiner must not only show that the modified reference includes *all* of the claimed elements, but also a convincing line of reason as to why one of ordinary skill in the art would have found the claimed invention to have been obvious in light of the teachings of the reference. *See Ex parte Clapp*, 227 U.S.P.Q. 972 (B.P.A.I. 1985). The Examiner must provide objective evidence, rather than subjective belief and unknown authority, of the requisite motivation or suggestion to modify the cited reference. *In re Lee*, 61 U.S.P.Q.2d. 1430 (Fed. Cir. 2002).

Applicants respectfully assert that claims 33-35 and 38 are allowable based on their dependency on claim 30. For this reason, claims 33-35 and 38 are allowable for the reasons outlined above. Thus, Applicants respectfully request withdrawal of the rejection of claims 33-35 and 38.

Independent claim 60 recites, “depositing an impurity into the contact hole onto the conductive material at a temperature that causes the conductive material to reflow...wherein the impurity is deposited into the contact hole *intermittently* with the deposition of the conductive material.” The Examiner did not point to any passages in the Kawano reference that disclose the recitation set forth above and upon carefully reviewing the Kawano reference Applicants are unable to find such disclosure. As discussed above, the Kawano reference does not disclose depositing an impurity into the contact hole wherein the impurity is deposited into the contact hole *intermittently* with the deposition of the conductive material.

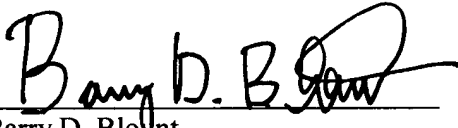
Accordingly, independent claim 60 and the claims dependent thereon are not obvious in view of the Kawano reference.

Conclusion

In view of the amendments and remarks set forth above, Applicants respectfully request withdrawal of all of the Examiner's rejections. Furthermore, Applicants assert that an indication of the allowability of claims 1, 30-38, 60-62, 64, and 65 is appropriate. If the Examiner believes that a telephonic interview will help speed this application toward issuance, the Examiner is invited to contact the undersigned at the telephone number listed below.

Respectfully submitted,

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